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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application No. of

Hisao HAYASHI

Application No.: **09/808,957**

Filed: March 16, 2001

Art Unit: **2822**

Examiner: Monica Lewis

FOR: SUBSTRATE FOR INTEGRATING AND FORMING A THIN FILM SEMICONDUCTOR DEVICE THEREON (as amended)

CERTIFIED TRANSLATION OF PRIORITY DOCUMENT

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313

Sir:

The Applicant, through its representatives and attorneys, hereby brings to the attention of the Examiner an English language translation of Japanese Patent Appl. No. P2000-075755, filed March 17, 2000.

The above-identified application is entitled to the benefit of the filing date of Japanese Patent Appl. No. P2000-075755. This Japanese Patent Application has a filing date of March 17, 2000.

Please take this English language translation into account

in the examination of this application and make its consideration of record.

If the Examiner has any comments or suggestions that could place this application in even better form, the Examiner is requested to telephone Brian K. Dutton, Reg. No. 47,255, at 202-955-8753 or the undersigned attorney at the below-listed number.

If any fee is required or any overpayment made, the Commissioner is hereby authorized to charge the fee or credit the overpayment to Deposit Account # 18-0013.

Respectfully submitted,

Ronald P. Kananen
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DATE: July 10, 2003

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Patent Application of	Group Art Unit: 2822
Hisao HAYASHI	Examiner: Lewis Monica
Serial No. 09/808,957	
Filed: March 16, 2001	
For: THIN FILM SEMICONDUCTOR DEVICE AND MANUFACTURING METHOD THEREOF	VERIFIED TRANSLATION OF PRIORITY DOCUMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

I declare that I can read and speak both the English and Japanese languages, and that I have translated, fully and accurately, the following Japanese application for which priority is claimed:

JAPANESE APPLICATION NO. P2000-075755

A copy of my English translation of the above priority application is attached hereto.

I further declare that all statements made herein of my knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or document or any registration resulting therefrom.

Dated: July 3, 2003

By: Yasuhito Kajikawa
Yasuhito KAJIKAWA

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[Title of the Invention]

THIN FILM SEMICONDUCTOR DEVICE AND MANUFACTURING METHOD THEREOF

[WHAT IS CLAIMED IS]

[Claim 1] A method of manufacturing a thin film semiconductor device, comprising:

a preparatory step of preparing a manufacturing substrate having a characteristic capable of enduring a process for forming a thin film transistor and a product substrate having a characteristic suitable to direct mounting of the thin film transistor,

a bonding step of bonding the manufacturing substrate to the product substrate for supporting the product substrate at the back,

a formation step of forming at least a thin film transistor to the surface of the product substrate in a state reinforced with the manufacturing substrate, and

a separation step of separating the manufacturing substrate after use from the product substrate.

[Claim 2] A method of manufacturing a thin film semiconductor device as claimed in claim 1, wherein the preparatory step comprises preparing the manufacturing substrate made of an inorganic material and a product substrate made of an organic substrate.

[Claim 3] A method of manufacturing a thin film semiconductor device as claimed in claim 2, wherein the formation step comprises forming a moisture proof film on the surface of the product substrate made of an organic material and then forming the thin film transistor thereon.

[Claim 4] A method of manufacturing a thin film semiconductor device as claimed in claim 1, wherein the bonding step comprises bonding the manufacturing substrate to the product substrate by using adhesives coated in a releasable state.

[Claim 5] A method of manufacturing a liquid crystal display device, comprising:

a preparatory step of preparing a manufacturing substrate having a characteristic capable of enduring a process for forming a thin film transistor and a product substrate having a characteristic suitable to direct mounting of the thin film transistor,

a bonding step of bonding the manufacturing substrate to the product substrate for supporting the product substrate at the back,

a formation step of forming at least a thin film transistor and a pixel electrode to the surface of the product substrate in a state reinforced with the manufacturing substrate,

a separation step of separating the manufacturing substrate after use from the product substrate, and

an assembling step of joining an opposing substrate previously formed with opposing electrodes at a predetermined distance to the product substrate formed with the pixel electrodes before or after the separation step, and injecting liquid crystals in the gap.

[Claim 6] A method of manufacturing a liquid crystal display device as claimed in claim 5, wherein the preparatory step comprises preparing a manufacturing substrate made of an inorganic material and a product substrate made of an organic substrate.

[Claim 7] A method of manufacturing a liquid crystal display device as claimed in claim 6, wherein the formation step comprises forming a moisture proof film on the surface of the product substrate made of an organic material and then forming the thin film transistor thereon.

[Claim 8] A method of manufacturing a liquid crystal display device as claimed in claim 5, wherein the bonding step comprises bonding the manufacturing substrate to the product substrate by using adhesives coated in a releasable state.

[Claim 9] A method of manufacturing an electroluminescence display device, comprising:

a preparatory step of preparing a manufacturing substrate having a characteristic capable of enduring a process for forming a thin film transistor and a product substrate having a

characteristic suitable to direct mounting of the thin film transistor,

a bonding step of bonding the manufacturing substrate to the product substrate for supporting the product substrate at the back,

a formation step of forming at least a thin film transistor and an electroluminescence device to the surface of the product substrate in a state reinforced with the manufacturing substrate, and

a separation step of separating the manufacturing substrate after use from the product substrate.

[Claim 10] A method of manufacturing an electroluminescence display device as claimed in claim 9, wherein the preparatory step comprises preparing a manufacturing substrate made of an inorganic material and a product substrate made of an organic substrate.

[Claim 11] A method of manufacturing an electroluminescence display device as claimed in claim 10, wherein the forming step comprises forming a moisture proof film on the surface of the product substrate made of an organic material and then forming the thin film transistor and electroluminescence device thereon.

[Claim 12] A method of manufacturing an electroluminescence display device as claimed in claim 9, wherein the bonding step comprises bonding the manufacturing substrate to the product

substrate by using adhesives coated in a releasable state.

[Claim 13] A thin film semiconductor device having a structure formed by using a manufacturing substrate having a characteristic capable of enduring a process for forming a thin film transistor and a product substrate having a characteristic suitable to direct mounting of the thin film transistor, bonding the manufacturing substrate to the product substrate for supporting the product substrate at the back, forming at least a thin film transistor to the surface of the product substrate in a state reinforced with the manufacturing substrate, and separating the manufacturing substrate after use from the product substrate.

[Claim 14] A thin film semiconductor device as claimed in claim 13, wherein a manufacturing substrate made of an inorganic material and a product substrate made of an organic material are used.

[Claim 15] A thin film semiconductor device as claimed in claim 14, wherein a moisture proof film is formed on the surface of the product substrate made of an organic material and then a thin film transistor is formed thereon.

[Claim 16] A liquid crystal display device having a structure formed by using a manufacturing substrate having a characteristic capable of enduring the process for forming a thin film transistor and a product substrate having a characteristic suitable to direct mounting of the thin film transistor, bonding the manufacturing

substrate to the product substrate for supporting the product substrate at the back, forming a thin film transistor and a pixel electrode on the surface of the product substrate in a state reinforced with the manufacturing substrate, joining an opposed substrate previously formed with opposing electrodes joined to the product substrate formed with the pixel electrode at a predetermined gap, possessing liquid crystals in the gap, and separating the manufacturing substrate after use from the product substrate.

[Claim 17] A liquid crystal display device as claimed in claim 16, wherein the manufacturing substrate made of an inorganic material and a product substrate made of an organic material are used.

[Claim 18] A liquid crystal display device as claimed in claim 17, wherein a moisture proof film is formed on the surface of the product substrate made of an organic material and then the thin film transistor is formed thereon.

[Claim 19] An electroluminescence display device having a structure formed by using a manufacturing substrate having a characteristic capable of enduring the process for forming a thin film transistor and a product substrate having a characteristic suitable to direct mounting of the thin film transistor, bonding the manufacturing substrate to the product substrate supporting the product substrate at the back, forming

a thin film transistor and a electroluminescence display device on the surface of the product substrate in a state reinforced with the manufacturing substrate, and separating the manufacturing substrate after use from the product substrate.

[Claim 20] An electroluminescence display device as claimed in claim 19, wherein a manufacturing substrate made of an inorganic material and a product substrate made of an organic material are used.

[Claim 21] An electroluminescence display device as claimed in claim 20, wherein a moisture proof film is formed on the surface of the product substrate made of the organic material and then a thin film transistor and an electroluminescence display device are formed thereon.

[Detailed Description of the Invention]

[0001]

[Industrial Field of Utilization]

The present invention relates to a thin film semiconductor device and a method of manufacturing the same. Specifically, it relates to a constitution of a substrate on which a thin film transistor is to be integrated and formed.

[0002]

[Prior Art]

A thin film semiconductor device generally is constituted such that a thin film transistor is integrated and formed on

an insulation substrate, e.g., made of glass. Forming the thin film transistor needs processes such as CVD (Chemical Vapor Deposition), cleaning and heat treatment. To successively apply such different processes, the substrate has to be transported between the stages for each process. To cope with it, automatic transportation using a manipulator is performed. However, if the substrate is accidentally deformed by warping etc., the automatic transportation may not be functioning well. Therefore, a substrate to be used for the thin film semiconductor device needs a heat resistance characteristic capable of enduring the temperature for forming the thin film transistor. The substrate also needs a predetermined thickness or more in order to prevent the substrate from warping deformation during transportation.

[0003]

[Problem to be Solved by the Invention]

On the other hand, products using the thin film semiconductor device as a component can include, e.g., an active matrix type liquid crystal display. In applying a liquid crystal display to portable equipments, the thin film semiconductor device needs to be structured so as to be lightweight and yet to have fracture toughness. This often disadvantageously brings about some difference between the condition required for manufacturing the thin film semiconductor device and the condition required for the device itself as end product, causing

some market-based complaints against the products. As described above, in manufacturing the substrate, use of glass is suitable in view of heat resistance while in view of the product conditions required for end product, the glass substrate has drawbacks of heavy weight and easy cracking. Specifically, the liquid display used for portable electronic equipments such as palm-top computers or mobile phones needs the material having the characteristics of: cost effective, lightweight, endurable against some deformation, and fracture toughness in the event of dropping, however the fact is that the glass substrate is heavy, sensitive to deformation, and liable to be broken in the event of dropping. This means that there are some intractable yet unresolved differences between the characteristics under restrictions due to manufacturing conditions and preferred characteristics required for the products as end product.

[0004]

Various countermeasures have been proposed so far in order to overcome such problems. For example, it has been attempted to use a plastic substrate, e.g., by lowering the process temperature for the thin film transistor as much as possible. However, the plastic substrate suffers from larger deformation compared with the glass substrate and no satisfactory products are obtained at present (N. D. Young, et al., Euro Display '96 Digest, 555, 1996). Further, there has been proposed a

countermeasure of once forming a thin film transistor to a provisional substrate and then transferring the same to another substrate (disclosed, e.g., in JP-A No. 243209/1999). However, this method suffers complexity in transfer step and involves a problem in view of productivity. Further, the method has a drawback in which the provisional substrate used for forming the thin film transistor and a substrate for mounting the thin film transistor as a product are different, thus causing the characteristics of the thin film transistor to be liable to be fluctuated owing to such a problem as stresses.

[0005]

[Means for Solving the Problem]

For overcoming the foregoing problems in the prior art, this invention provides a method of manufacturing a thin film semiconductor device comprising: a preparatory step of preparing a manufacturing substrate having a characteristic capable of enduring a process for forming a thin film transistor and a product substrate having a characteristic suitable to direct mounting of the thin film transistor, a bonding step of bonding the manufacturing substrate to the product substrate for supporting the product substrate at the back, a formation step of forming at least a thin film transistor to the surface of the product substrate in a state reinforced with the manufacturing substrate, and a separation step of separating the manufacturing substrate

after use from the product substrate. Preferably, in the preparatory step, a manufacturing substrate made of an inorganic material and a product substrate made of an organic material are prepared. Optionally, in the formation step, a moisture proof film is formed on the surface of a product substrate made of an organic material and then a thin film transistor is formed thereon. Further, in the bonding step, the manufacturing substrate is bonded to the product substrate by using adhesives coated in the releasable manner.

[0006]

Further, this invention provides a method of manufacturing a liquid crystal display device comprising: a preparatory step of preparing a manufacturing substrate having a characteristic capable of enduring a process for forming a thin film transistor and a product substrate having a characteristic suitable to direct mounting of the thin film transistor, a bonding step of bonding the manufacturing substrate to the product substrate for supporting the product substrate at the back, a formation step of forming at least a thin film transistor and a pixel electrode to the surface of the product substrate in a state reinforced with the manufacturing substrate, a separation step of separating the manufacturing substrate after use from the product substrate, and an assembling step of joining an opposing substrate previously formed with opposing electrodes at a predetermined distance to

the product substrate formed with the pixel electrodes before or after the separation step, and injecting liquid crystals in the gap.

[0007]

Furthermore, this invention provides a method of manufacturing an electroluminescence display device comprising: a preparatory step of preparing a manufacturing substrate having a characteristic capable of enduring a process for forming a thin film transistor and a product substrate having a characteristic suitable to direct mounting of the thin film transistor, a bonding step of bonding the manufacturing substrate to the product substrate for supporting the product substrate at the back, a formation step of forming at least a thin film transistor and an electroluminescence device to the surface of the product substrate in a state reinforced with the manufacturing substrate, and a separation step of separating the manufacturing substrate after use from the product substrate.

[0008]

According to this invention, in the preparatory step before forming the thin film transistor, a manufacturing substrate, e.g., made of glass is previously appended to a product substrate, e.g., made of a plastic material for reinforcement. Subsequently, a thin film transistor is integrated and formed on a product substrate made, e.g., of a plastic material. In this case, since

the product substrate made, e.g., of a plastic material or the like is backed by the manufacturing substrate made, e.g., of glass, it has a rigidity as a whole capable of enduring the transportation by manipulators. Then, at the instance the manufacturing process for the thin film transistor has been completed, the manufacturing substrate after use is separated from the product substrate. Finally, the thin film transistor is supported only by a thin and lightweight product substrate. An active matrix type liquid crystal display using a plastic substrate is suitable to the application use to the portable equipments.

[0009]

[Preferred Embodiments]

Preferred embodiments of this invention are to be described in details with reference to the drawings. Fig. 1 is examples of schematic step charts illustrating a method of manufacturing a thin film semiconductor device according to this invention. At first, as shown in Fig. 1(A), a manufacturing substrate 20 having characteristics durable to the process for forming a thin film transistor and a product substrate 1 having characteristics suitable to direct mounting of a thin film transistor are prepared. In the preparatory step, a manufacturing substrate 20 made of an inorganic material such as glass and a product substrate 1 made of an organic material such as plastic are prepared. In

this embodiment, non-alkali glass is used as the manufacturing substrate 20. The heat resistance of the non-alkali glass is about 500°C. The standard thickness for the manufacturing substrate 20 is, e.g., 0.7 mm. If it is reduced to 0.5 mm, there is no particular problem in view of the manufacturing process. In this embodiment, non-alkali glass is used but, instead, metal plate such as of stainless steel, plastic plate, quartz and the like can be also be used. On the other hand, for the manufacturing substrate 1, it is necessary that it has such a heat resistance as capable of withstanding the processing temperature of a thin film transistor and that the substrate is thinner and lighter compared with the manufacturing substrate 20. In this embodiment, a plastic material is used with a thickness from about 0.1 mm to 0.5 mm. Particularly, polyether sulfone resin (PES), polyethylene terephthalate resin or ARTON resin are used in terms of excellent heat resistance. For instance, the polyether sulfone resin has the heat resistance to the temperature of about 250°C. The plastic film used for the manufacturing substrate 1 may be a single layer and, depending on the case, may have a laminate structure. Particularly, when a use is made for a reflection type display instead of for a transmission type display, a metal plate may be used instead of the plastic material. However, when the metal plate is used, its surface has to be insulated. Concretely, when an aluminum plate is used for the product

substrate 1, its surface has to be previously covered with alumina.

[0010]

Successively, as shown in Fig. 1(A), the manufacturing substrate 20 is bonded to the product substrate 1 in order to support the product substrate 1 at the back. In the bonding step, the manufacturing substrate 20 is bonded to the product substrate 1 by using, e.g., an adhesive 21 coated in a releasable state. In this embodiment, a heat resistant resin is coated as the adhesive 21. Since the resin has to endure heat upon forming the thin film transistor, a polyimide, silicon or Teflon type resin is used. However, when the processing temperature for the thin film transistor is lowered, various adhesives can be used. Coating is conducted by spin coating or printing a liquid material. Alternatively, there is a method for coating by appending a film-shaped adhesive to one of the substrate surfaces and then melting the same by heating. The adhesive 21 is not restricted only to the organic material but silicon or germanium and, further, metal (lead, aluminum, molybdenum, nickel or tin) may also be used. When such a material is used, it is formed as a film by a sputtering or the like to one of the substrates and bonded to the other of the substrates while being melted under laser irradiation or the like. In a case of using an aluminum plate as the product substrate 1, there is no need of using the adhesive 21. In that case, a product substrate 1 made of aluminum or the

like and a manufacturing substrate 20 made of glass may be bonded directly by using an optical energy such as of laser.

[0011]

Successively, as shown in Fig. 1(B), a thin film device such as a thin film transistor 3 is integrated and formed on the surface of the product substrate 1 in a state reinforced with the manufacturing substrate 20. Specifically, after forming film of a metal such as tantalum or molybdenum by a sputtering method or the like, the formed film is patterned by isotropic dry etching to fabricate into a gate electrode 5. Successively, SiO_2 is deposited, e.g., to a thickness of 100 to 200 nm by a plasma CVD method (PE-CVD method) to form a gate insulation film 4 for covering the gate electrode 5. Amorphous silicon is deposited further thereon to a thickness, e.g., of 20 to 60 nm to form a semiconductor thin film 2. The insulation film 4 and the semiconductor thin film 2 can be grown continuously without breaking vacuum in one identical film forming chamber. Subsequently, the semiconductor thin film 2 is crystallized, e.g., by irradiating an XeCl excimer laser beam at a wavelength of 308 nm for an extremely short period of time. The amorphous silicon is melted by the energy of the laser beam and forms polycrystal silicon when solidified. Since the irradiation time of the laser beam is extremely short, it gives no damages to the product substrate 1. Subsequently, resist is coated on the

semiconductor thin film 2 and back face exposure is applied by using a light shielding gate electrode 5 as a mask to obtain a mask aligned with the gate electrode 5 in self-alignment. Then, impurities (for example, phosphorus) are implanted by way of the mask by an ion doping method into the semiconductor thin film 2 at a relatively low concentration. Further, after covering the mask and the peripheral thereof with another photoresist, impurities (for example, phosphorus) are implanted at a relatively high concentration by an ion doping method to the semiconductor thin film 2. A source region S and a drain region D are thus formed. Further, a channel region Ch previously implanted with P-type impurities (for example, boron) for threshold value control is left just above the gate electrode 5. Between the channel region Ch, and the source region S or the drain region D, an LDD region implanted with N-type impurities such as phosphorus at a relatively low concentration is left. Subsequently, unnecessary photoresist is removed. The ion doping method is a method of doping ions in a plasma state under electric field acceleration all at once into the semiconductor thin film 2 that enables short time processing. Successively, a laser beam is irradiated again for activating the doped atoms. This is the same method as for crystallization but a weak energy may suffice since there is no requirement for growing the crystals. Then, SiO_2, e.g., is deposited to form an interlayer film 9 for

insulation between interconnections. After making a contact hole in the interlayer film 9, metal aluminum or the like is deposited by sputtering, patterned to a predetermined shape and fabricated into interconnections 10. In the subsequent procedures, in a case of manufacturing a thin film semiconductor device for use in an active matrix type liquid crystal display, a protection film 12 or a pixel electrode 14 is formed optionally. Further, an assembling step is applied by bonding an opposing substrate previously formed with opposing electrodes to the product substrate formed with the pixel electrode 14 at a predetermined distance, and injecting liquid crystals into the gap. On the other hand, in a case of using the thin film semiconductor device for an active matrix type organic electroluminescence display, an organic electroluminescence device is previously formed on the pixel electrode 14.

[0012]

Finally, as shown in Fig. 2, a separation step of separating the used manufacturing substrate 20 from the productivity substrate 1 is applied. Specifically, both of the substrates can be separated by dissolving adhesives interposed between the manufacturing substrate 20 and the product substrate 1 in a solvent. The solvent used is different depending on the material of the adhesives. Generally, adhesive layer is extremely thin and takes much time until the solvent intrudes. Then, it is effective to

promote the dissolution of the adhesives by using an energy such as of supersonic waves or laser beams. In the previous bonding step, it is not necessary to uniformly coat the adhesive over the entire surface of the substrate. Rather, dissolution using the solvent is facilitated by coating the adhesives discretely. As described above, since only the product substrate 1 made of the plastic material or the like is left to the final product, a display light in weight and reduced in the thickness can be obtained. In the case of preparing a liquid crystal display, the assembling step described above may be applied after separation of the manufacturing substrate 20.

[0013]

In the embodiment described above, a thin film transistor of the bottom gate structure has been formed on the substrate 1. Alternatively, a thin film transistor of a top gate structure may be integrated and formed. Fig. 3 shows this embodiment. For easy understanding, corresponding reference numerals are attached to those portions corresponding to the previous embodiment shown in Fig. 1 and Fig. 2. As shown in the drawing, in the thin film transistor of the top gate structure, the gate electrode 5 is formed by way of the gate insulation film 4 on the semiconductor thin film 2. In this embodiment, a moisture proof buffer film 30 is formed previously between the product substrate 1 and the thin film transistor. The buffer film 30

comprises a silicon oxide film or a silicon nitride film formed by a CVD or sputtering method, which stops water passing through the manufacturing substrate 1 and suppresses impurities from intruding into the substrate. In a case of using a plastic material for the product substrate 1, it is sometimes preferred to form a buffer film particularly as a moisture proof countermeasure.

[0014]

Fig. 4 is a schematic perspective view illustrating an example of an active matrix type liquid crystal display device assembled by using a thin film semiconductor device according to this invention as a driving substrate. The liquid crystal display device has a panel structure of possessing liquid crystals 50 between a product substrate 1 and an opposed substrate 60. A pixel array area and a peripheral circuit area are integrated and formed by the same thin film transistor as described above on the product substrate 1. The peripheral circuit area is divided into a vertical scanning circuit 41 and a horizontal scanning circuit 42. Further, terminal electrodes 47 for external connection are also formed on the upper end of the product substrate 1. Each of the terminal electrode 47 is connected by way of interconnections 48 to the vertical scanning circuit 41 and the horizontal scanning circuit 42. Gate interconnections 43 and signal interconnections 10 crossing to each other are

formed in the pixel array area. The gate electrode 43 is connected with the vertical scanning circuit 41 while the signal interconnection 10 is connected with the horizontal scanning circuit 42. A pixel electrode 14 and a thin film transistor 3 for driving the same are formed at the intersection between both of the interconnections 43 and 10. On the other hand, counter electrodes (not shown) are formed to the inner surface of the opposing substrate 60. When plastic material is used for the product substrate 1 and identical plastic material is used as the opposing substrate 60, a panel extremely light in weight and resistant to damages can be obtained.

[0015]

Fig. 5 is a schematic fragmentary cross sectional view illustrating an active matrix type electroluminescence display device assembled using a thin film semiconductor device according to this invention as a driving substrate. In this embodiment, an organic electroluminescence device OLED is used as a pixel. The OLED comprises an anode A, an organic layer 110 and a cathode K in a manner of stacking them one by one. The anode A is isolated on every pixels and made, e.g., of chromium and basically light reflecting. The cathode K is connected in common between each of the pixels, has a laminate structure, e.g., of a metal layer 111 and a transparent conduction layer 112 and is basically light permeable. When a forward voltage (at about 10 V) is applied

between the anode A and the cathode K of the OLED of such a structure, injection of carriers such as electrons or positive holes occurs and light emission is observed. It is considered that the operation of the OLED is light emission caused by exciters formed with holes injected from the anode A and electrons injected from the cathode K.

[0016]

On the other hand, a thin film transistor 3 for driving the OLED comprises a gate electrode 5 formed on a product substrate 1 made, e.g., of a plastic material, a gate insulation film 4 stacked thereon, and a semiconductor thin film 2 stacked above the gate electrode 5 by way of the gate insulation film 4. The semiconductor thin film 2 comprises, e.g., a silicon thin film crystallized by laser annealing. The thin film transistor 3 comprises a source region S, a channel region Ch, and a drain region D as a passage for the current supply to the OLED. The channel region Ch situates just above the gate electrode 5. The thin film transistor 3 having the bottom gate structure is covered with an interlayer film 9, on which interconnections 10 are formed. The film of the OLED described above is formed on them by way of another interlayer film 11. The anode A of the OLED is electrically connected by way of the interconnections 10 to the thin film transistor 3.

[0017]

[Effect of the Invention]

As has been described above, this invention has a structure where: the manufacturing substrate having a characteristic durable to the process for forming the thin film transistor and the product substrate having a characteristic suitable to direct mounting of the thin film transistor are used; the manufacturing substrate is bonded to the product substrate for supporting the product substrate at the back; at least the thin film transistor is formed on the surface of the product substrate in a state reinforced with the manufacturing substrate; and the manufacturing substrate after use is separated from the product substrate. In the manufacturing steps, since the thin film transistor is integrated and formed on the substrate reinforced with bonding, handling for substrate, etc. can be facilitated to contribute to the stabilization of the process. On the other hand, since the manufacturing substrate after use is separated in a stage where the product is completed, the product itself is reduced in the weight and the thickness. In addition, the separated manufacturing substrate can further be utilized again to the thin film transistor manufacturing process, making it possible for recycling of resource.

[Brief Description of the Drawings]

[Fig. 1]

Step charts illustrating a method of manufacturing a thin

film semiconductor device according to this invention;

[Fig. 2]

A step chart illustrating a method of manufacturing a thin film semiconductor device according to this invention;

[Fig. 3]

A fragmentary cross sectional view illustrating another embodiment of a thin film semiconductor device according to this invention;

[Fig. 4]

A perspective view illustrating a liquid crystal display device according to this invention; and

[Fig. 5]

A schematic cross sectional view illustrating an electroluminescence display device according to this invention.

[Explanation of Reference Numerals]

1. product substrate
2. semiconductor thin film
3. thin film transistor
4. gate insulation film
5. gate electrode
14. pixel electrode
20. manufacturing substrate
21. adhesive

ABSTRACT OF THE DISCLOSURE

[Abstract]

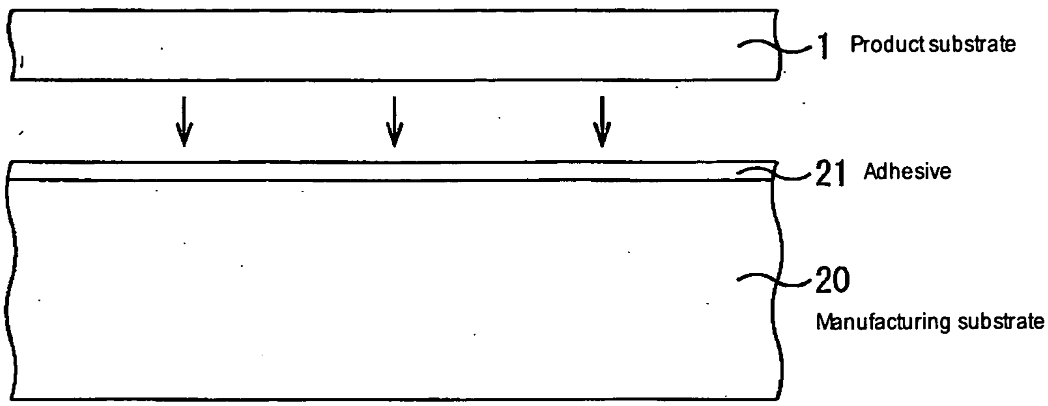
[Object] To provide substrates, in manufacturing a thin film semiconductor device, suitable for conditions of the manufacturing process and of the device as end product.

[Constitution] To attain the object, provided are a preparatory step where manufacturing substrate 20 having a characteristic capable of enduring a process for forming a thin film transistor 3 and a product substrate 1 having a characteristic suitable to direct mounting of the thin film transistor 3 is prepared; a bonding step where the manufacturing substrate 20 is bonded to the product substrate 1 in order to support the product substrate 1 at the back; a formation step where at least a thin film transistor 3 is formed to the surface of the product substrate 1 with the product substrate 1 being reinforced by the manufacturing substrate 20; and a separation step where the manufacturing substrate 20 after use is separated from the product substrate 1.

[Selected Drawing] Fig. 1

FIG.1

(A)


1 Product substrate
21 Adhesive
20
Manufacturing substrate

(B)

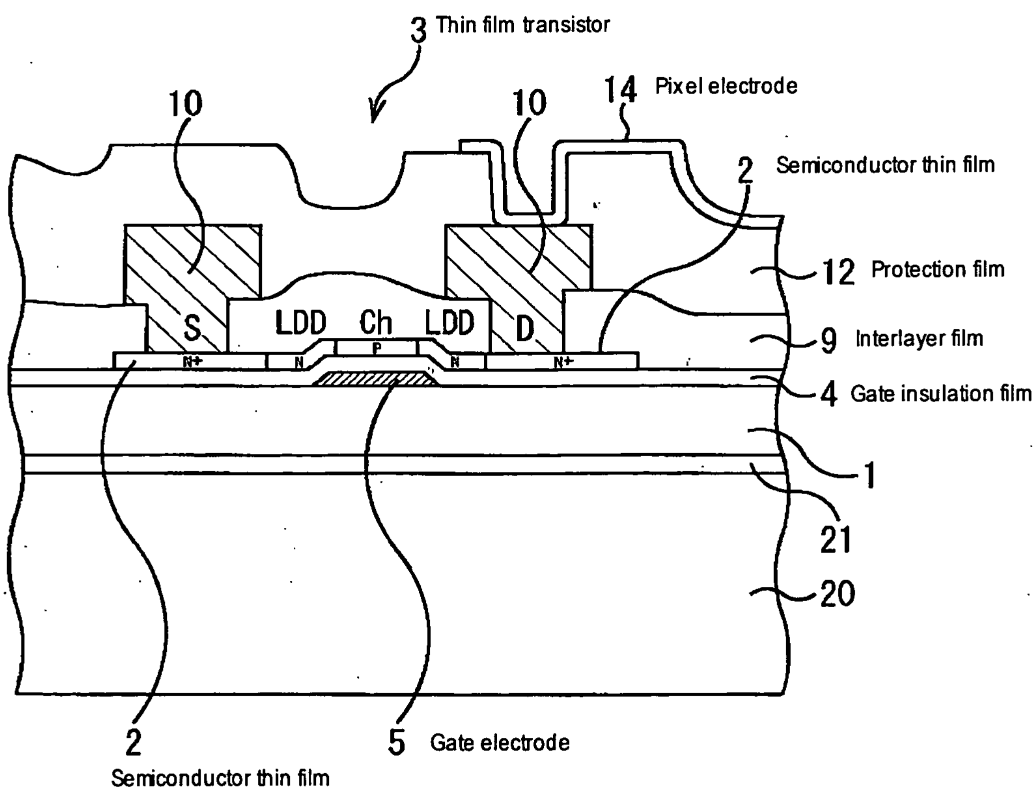

3 Thin film transistor
10
10
14 Pixel electrode
2 Semiconductor thin film
12 Protection film
9 Interlayer film
4 Gate insulation film
1
21
20
S
LDD
Ch
LDD
D
2
Semiconductor thin film
5 Gate electrode

FIG.2

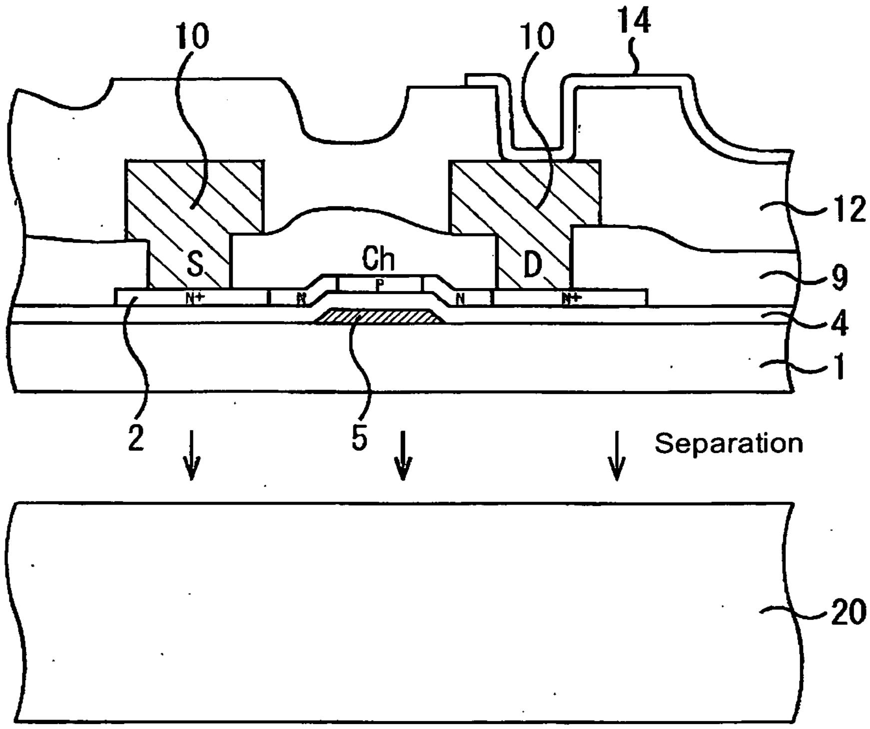

10
10
14
S
Ch
D
N+
N
P
N
N+
12
9
4
1
2
5
Separation
20

FIG.3

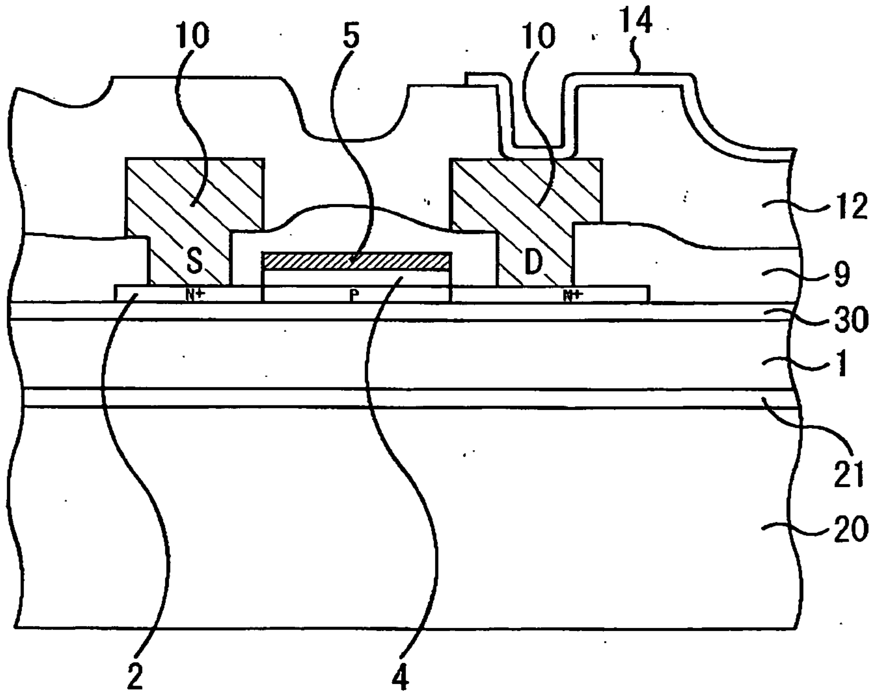

10
5
10
14
S
D
N+
P
N+
12
9
30
1
21
20
2
4

FIG.4

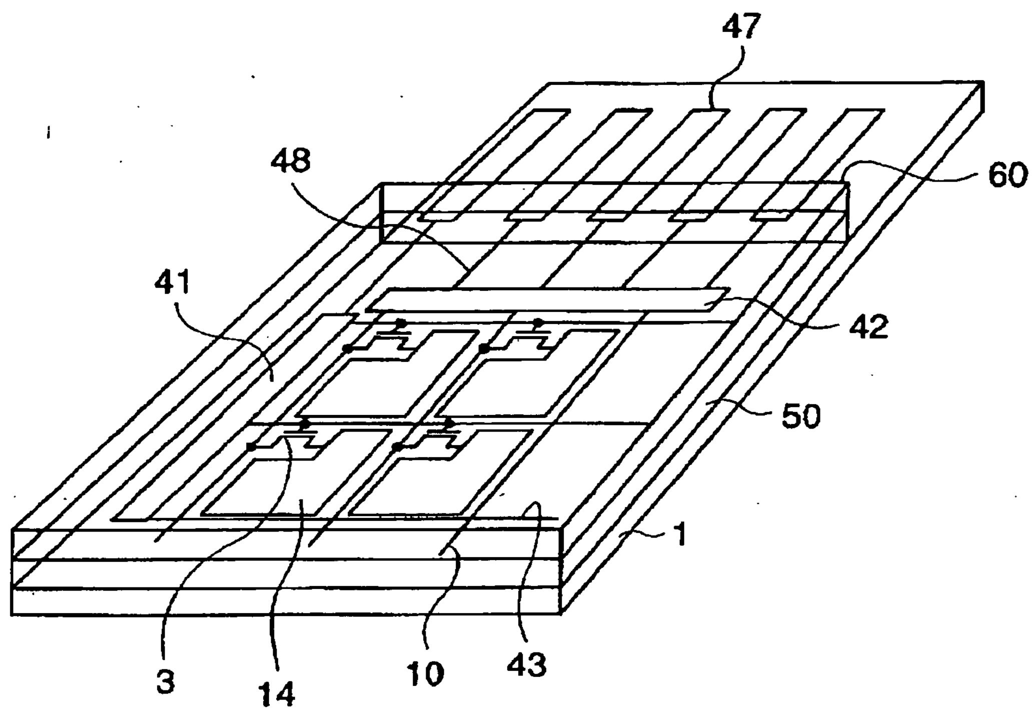
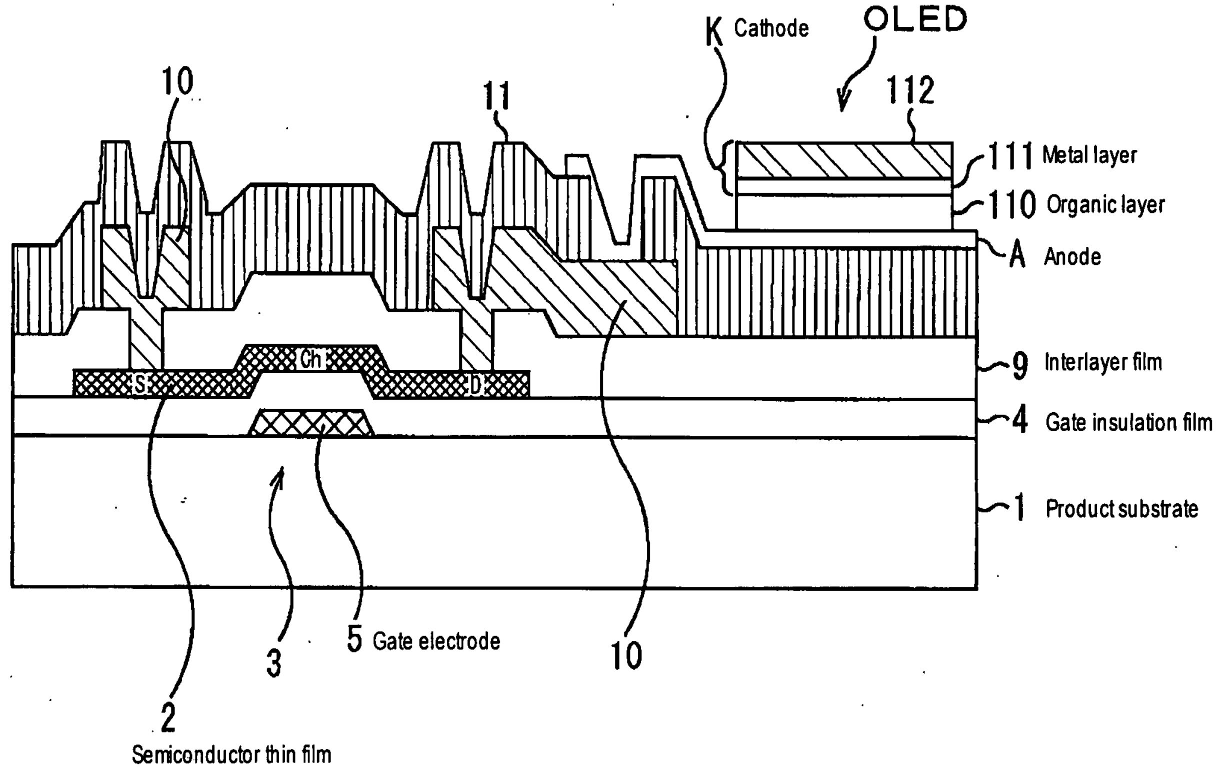


FIG.5


K Cathode
OLED
112
10
11
111 Metal layer
110 Organic layer
A Anode
Ch
S
D
9 Interlayer film
4 Gate insulation film
1 Product substrate
3
5 Gate electrode
10
2
Semiconductor thin film